

§18. Spectral Emissions of Carbon Ions from Ionizing and Recombining LHD Plasmas

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In low temperature plasmas such as divertor or process plasmas, emission from impurities is important for plasma diagnostics and plasma modeling. We calculated the DR (dielectronic recombination) rate coefficients to each excited state distinguishing the configuration, spin and terms (up to $n = 6$) of neutral carbon and the L-shell ions: C^{+0} , C^{+1} and C^{+2} [1 - 3]. We made collisional radiative models for carbon L-shell ions including both ionization/excitation and recombination processes. Using our new collisional radiative models for carbon atom and ions, we calculate line intensities for temperature and density diagnostics using the intensity ratios of singlet ($2s^2\ ^1S - 2s2p\ ^1P$) and triplet ($2s2p\ ^3P - 2p^2\ ^3P$) lines from C^{+2} ions. In this work we apply these models to observed spectra from LHD in NIFS.

Time dependent UV Spectra ($\sim 1000\text{\AA}$) were measured in LHD plasma heated by ECH (#15080). Spectra were taken every 184 ms with 20ms exposure time. We compare to measured spectra in LHD for cases where the spectra can be classified as ionizing (3-5) or recombining plasma (6 - 8).

We obtain plausible electron temperatures from the CIII spectra for ionizing phase $T_e = 30 - 40\text{ eV}$ (3-5) and for recombining phase $T_e = 2 - 3\text{ eV}$ (6) and $T_e \sim 0.1\text{ eV}$ (7). We also derived electron temperature and density from the observed Lyman series intensity ratios of Hydrogen ($n = 3 - 7$) to be $T_e = 0.4\text{ eV}$, $N_e = 10^{13}\text{ cm}^{-3}$ (7) and $T_e = 0.3\text{ eV}$, $N_e = 10^{12}\text{ cm}^{-3}$ (8).

We calculated the time variation of ion abundances after the heating stops including the density and temperature variation. The temperature decreases very rapidly within 0.1- 0.2 sec. We could explain the time variation of line intensities of OV, CIII, HeI and HI qualitatively. However for C^{+2} ions the calculated decay is slower than the measurement. One explanation of this disagreement would be ion flow. It is possible the C^{+2} ions are replaced by neutral carbon from the walls with a time scale of about 10 ms. We will study this question in great detail.

LHD plasma is found to be a good source to study

recombining plasmas.

In this project we have advanced to more direct application of our techniques and codes to plasma diagnostics and plasma modeling.

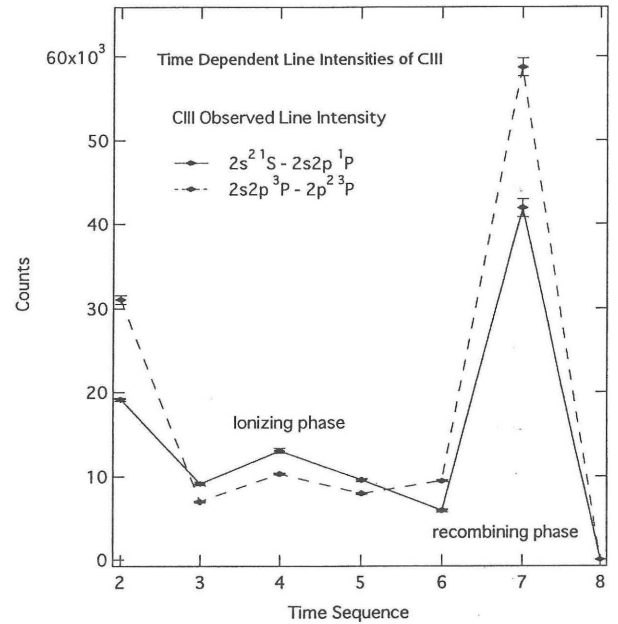


Fig.1. Time dependent observed CIII emission lines from LHD

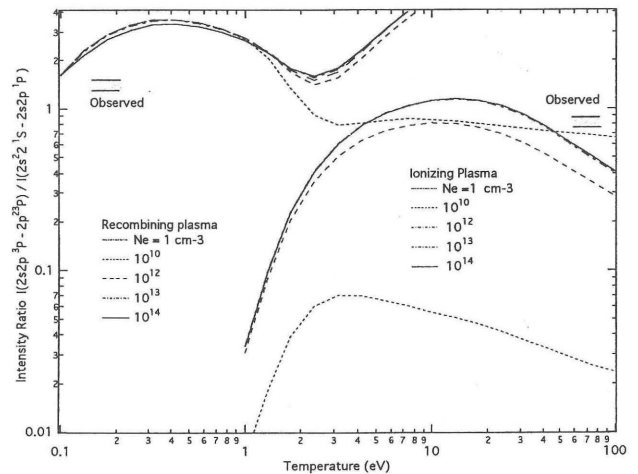


Fig.2. Calculated Intensity ratios for CIII in Ionizing plasma and Recombining plasma with the observed values.

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